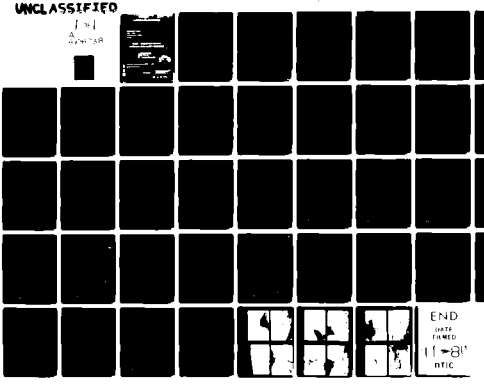
AD-A106 738 ANDERSON ENGINEERING INC SPRINGFIELD MO F/G 13/13
NATIONAL DAM SAFETY PROGRAM. DUCK CREEK STATE WILDLIFE REFUGE --ETC(U)
DEC 80 S L BRADY, T R BECKLEY, G WERTEPNY DACW43-80-C-0073
UNCLASSIFIED NL



SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER

2. GOVT ACCESSION NO. AD-A106738

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)
Phase I Dam Inspection Report
National Dam Safety Program
Duck Creek State Wilflife Refuge No. 3 (MO 40094)
Stoddard County, Missouri

5. TYPE OF REPORT & PERIOD COVERED
Final Report

6. PERFORMING ORG. REPORT NUMBER

7. AUTH
Steven L. /Brady Tom R. /Beckley
Gene /Wertepny Danny /Kerns
Anderson Engineering

8. CONTRACT OR GRANT NUMBER(s)
DACW43-80-C-0073

9. PERFORMING ORGANIZATION NAME AND ADDRESS
U.S. Army Engineer District, St. Louis
Dam Inventory and Inspection Section, LMSED-PD
210 Tucker Blvd., North, St. Louis, Mo. 63101

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS
U.S. Army Engineer District, St. Louis
Dam Inventory and Inspection Section, LMSED-PD
210 Tucker Blvd., North, St. Louis, Mo. 63101

12. REPORT DATE
December 1980

13. NUMBER OF PAGES
Approximately 55

14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)

15. SECURITY CLASS. (of this report)
UNCLASSIFIED

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT
National Dam Safety Program. Duck Creek State Wildlife Refuge - Pond Number 3 (MO 40094), Mississippi - St. Francis River Basin, Stoddard County, Missouri. Phase I Inspection Report.

Approved for release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

412554

JDB

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

INSTRUCTIONS FOR PREPARATION OF REPORT DOCUMENTATION PAGE

RESPONSIBILITY. The controlling DoD office will be responsible for completion of the Report Documentation Page, DD Form 1473, in all technical reports prepared by or for DoD organizations.

CLASSIFICATION. Since this Report Documentation Page, DD Form 1473, is used in preparing announcements, bibliographies, and data banks, it should be unclassified if possible. If a classification is required, identify the classified items on the page by the appropriate symbol.

COMPLETION GUIDE

General. Make Blocks 1, 4, 5, 6, 7, 11, 13, 15, and 16 agree with the corresponding information on the report cover. Leave Blocks 2 and 3 blank.

Block 1. Report Number. Enter the unique alphanumeric report number shown on the cover.

Block 2. Government Accession No. Leave Blank. This space is for use by the Defense Documentation Center.

Block 3. Recipient's Catalog Number. Leave blank. This space is for the use of the report recipient to assist in future retrieval of the document.

Block 4. Title and Subtitle. Enter the title in all capital letters exactly as it appears on the publication. Titles should be unclassified whenever possible. Write out the English equivalent for Greek letters and mathematical symbols in the title *(see "Abstracting Scientific and Technical Reports of Defense-sponsored RDT/E," AD-667 000)*. If the report has a subtitle, this subtitle should follow the main title, be separated by a comma or semicolon if appropriate, and be initially capitalized. If a publication has a title in a foreign language, translate the title into English and follow the English translation with the title in the original language. Make every effort to simplify the title before publication.

Block 5. Type of Report and Period Covered. Indicate here whether report is interim, final, etc., and, if applicable, inclusive dates of period covered, such as the life of a contract covered in a final contractor report.

Block 6. Performing Organization Report Number. Only numbers other than the official report number shown in Block 1, such as series numbers for in-house reports or a contractor/grantee number assigned by him, will be placed in this space. If no such numbers are used, leave this space blank.

Block 7. Author*(s)*. Include corresponding information from the report cover. Give the name*(s)* of the author*(s)* in conventional order *(for example, John R. Doe or, if author prefers, J. Robert Doe)*. In addition, list the affiliation of an author if it differs from that of the performing organization.

Block 8. Contract or Grant Number*(s)*. For a contractor or grantee report, enter the complete contract or grant number*(s)* under which the work reported was accomplished. Leave blank in in-house reports.

Block 9. Performing Organization Name and Address. For in-house reports enter the name and address, including office symbol, of the performing activity. For contractor or grantee reports enter the name and address of the contractor or grantee who prepared the report and identify the appropriate corporate division, school, laboratory, etc., of the author. List city, state, and ZIP Code.

Block 10. Program Element, Project, Task Area, and Work Unit Numbers. Enter here the number code from the applicable Department of Defense form, such as the DD Form 1498, "Research and Technology Work Unit Summary" or the DD Form 1634, "Research and Development Planning Summary," which identifies the program element, project, task area, and work unit or equivalent under which the work was authorized.

Block 11. Controlling Office Name and Address. Enter the full, official name and address, including office symbol, of the controlling office. *(Equates to funding/sponsoring agency. For definition see DoD Directive 5200.20, "Distribution Statements on Technical Documents.")*

Block 12. Report Date. Enter here the day, month, and year or month and year as shown on the cover.

Block 13. Number of Pages. Enter the total number of pages.

Block 14. Monitoring Agency Name and Address *(if different from Controlling Office)*. For use when the controlling or funding office does not directly administer a project, contract, or grant, but delegates the administrative responsibility to another organization.

Blocks 15 & 15a. Security Classification of the Report: Declassification/Downgrading Schedule of the Report. Enter in 15 the highest classification of the report. If appropriate, enter in 15a the declassification/downgrading schedule of the report, using the abbreviations for declassification/downgrading schedules listed in paragraph 4-207 of DoD 5200.1-R.

Block 16. Distribution Statement of the Report. Insert here the applicable distribution statement of the report from DoD Directive 5200.20, "Distribution Statements on Technical Documents."

Block 17. Distribution Statement *(of the abstract entered in Block 20, if different from the distribution statement of the report)*. Insert here the applicable distribution statement of the abstract from DoD Directive 5200.20, "Distribution Statements on Technical Documents."

Block 18. Supplementary Notes. Enter information not included elsewhere but useful, such as: Prepared in cooperation with . . . Translation of *(or by)* . . . Presented at conference of . . . To be published in . . .

Block 19. Key Words. Select terms or short phrases that identify the principal subjects covered in the report, and are sufficiently specific and precise to be used as index entries for cataloging, conforming to standard terminology. The DoD "Thesaurus of Engineering and Scientific Terms" *(TEST)*, AD-672 000, can be helpful.

Block 20. Abstract. The abstract should be a brief *(not to exceed 200 words)* factual summary of the most significant information contained in the report. If possible, the abstract of a classified report should be unclassified and the abstract to an unclassified report should consist of publicly- releasable information. If the report contains a significant bibliography or literature survey, mention it here. For information on preparing abstracts see "Abstracting Scientific and Technical Reports of Defense-Sponsored RDT&E," AD-667 000.

☆ U.S. G.P.O. 1980-665-141/1299

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

SUBJECT: Duck Creek State Wildlife Refuge - Pond 3
Stoddard County, Missouri
Missouri Inventory No. 40094

This report presents the results of field inspection and evaluation of the Duck Creek State Wildlife Refuge - Pond 3. It was prepared under the National Program of Inspection of Non-Federal Dams.

SUBMITTED BY: SIGNED
Chief, Engineering Division

01 APR 1981
Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer

03 APR 1981
Date

MISSISSIPPI-ST. FRANCIS RIVER BASIN

DUCK CREEK STATE WILDLIFE REFUGE - POND 3
STODDARD COUNTY, MISSOURI
MISSOURI INVENTORY NO. 40094

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared By

Anderson Engineering, Inc., Springfield, Missouri
Hanson Engineers, Inc., Springfield, Illinois

Under Direction Of

St. Louis District, Corps of Engineers

For

Governor of Missouri

December, 1980

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM
SUMMARY

Name of Dam: Duck Creek State Wildlife Refuge - Pond 3
State Located: Missouri
County Located: Stoddard
Stream: None
Date of Inspection: October 8, 1980

Duck Creek State Wildlife Refuge - Pond 3 was inspected by an interdisciplinary team of engineers from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The purpose of this inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers, and they have been developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, the St. Louis District, Corps of Engineers has determined that this dam is in the significant hazard potential classification, which means that some loss of life and appreciable property loss could occur if the dam fails. The estimated damage zone extends approximately one mile downstream of the dam. Located within this zone are the town of Kinder (few dwellings), a railroad, and Highway 51.

The dam is in the intermediate size classification, since the storage capacity is greater than 1,000 Acre-ft.

Our inspection and evaluation indicates that the spillways do not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillways will pass 35 percent of the Probable Maximum Flood without overtopping. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The guidelines require that a dam of intermediate size with a significant downstream hazard potential pass 50 to 100 percent of the PMF. Considering the low height of the dam, the low storage capacity, and the short duration of permanent water impoundment, 50 percent of the PMF has been determined

to be the appropriate spillway design flood. The 100-year flood (1 percent probability flood) will not overtop the dam. The 1 percent probability flood is one that has a 1 percent chance of being exceeded in any given year.

The embankment was in good condition. A deficiency visually observed by the inspection team was: The thick growth of trees on the embankment slopes.

Another deficiency was the lack of seepage and stability analysis records.

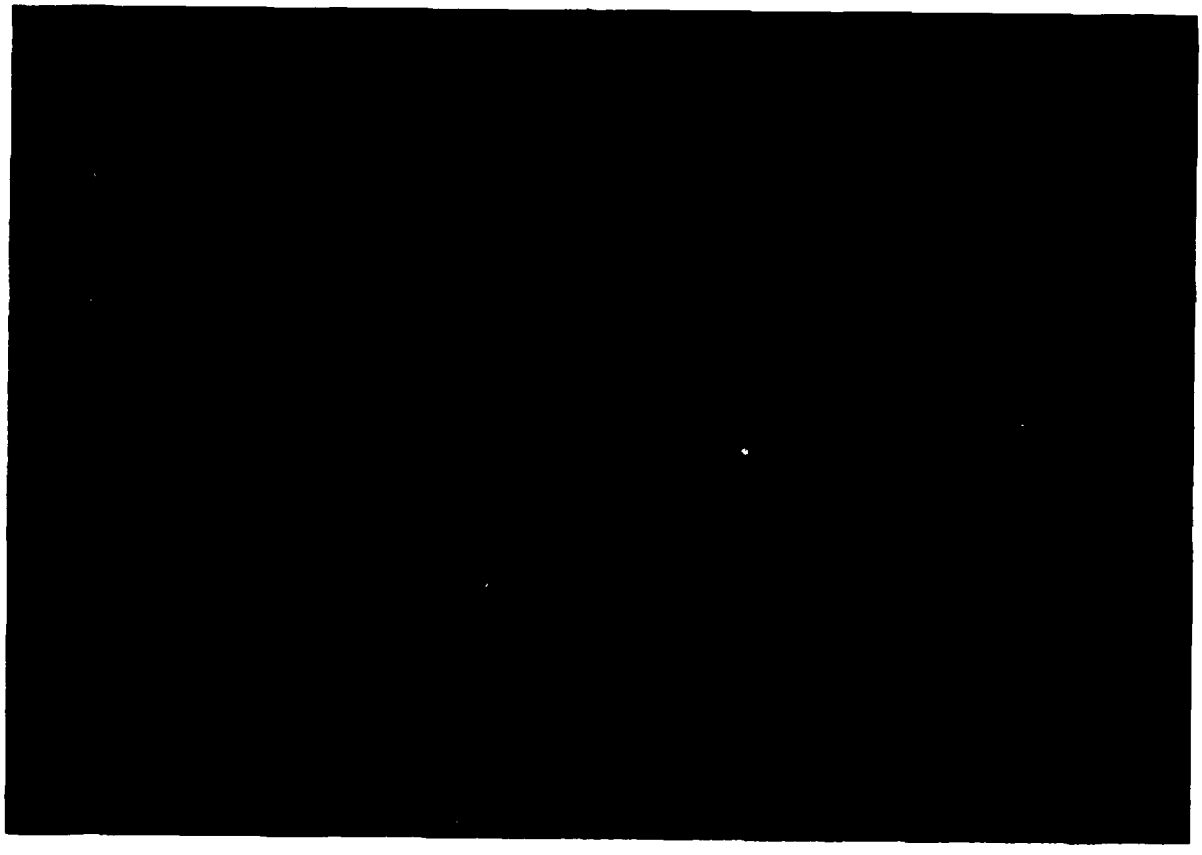
It is recommended that the owners take the necessary action to correct the deficiencies reported herein. A detailed discussion of these deficiencies is included in the following report.

Steven L. Brady, P.E.
Anderson Engineering, Inc.

Tom R. Beckley, P.E.
Anderson Engineering, Inc.

Gene Wertepny, P.E.
Hanson Engineers, Inc.

Dan Kerns, P.E.
Hanson Engineers, Inc.



AERIAL VIEW OF LAKE AND DAM
(Looking Northwest)

Note: Pond No. 1 is visible in upper right of Photo

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
DUCK CREEK STATE WILDLIFE REFUGE - POND 3
STODDARD COUNTY, MISSOURI
MISSOURI INVENTORY NO. 40094

TABLE OF CONTENTS

APPENDICES

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL:

A. Authority:

The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection be made of Duck Creek State Wildlife Refuge - Pond 3 in Stoddard County, Missouri.

B. Purpose of Inspection:

The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and a visual inspection in order to determine if the dam poses hazards to human life or property.

C. Evaluation Criteria:

Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, "Recommended Guidelines for Safety Inspection of Dams, Appendix D." These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT:

A. Description of Dam and Appurtenances:

Duck Creek State Wildlife Refuge - Pond 3 is an earth fill structure approximately 7.3 ft high and 14,700 ft long at the crest. The pond was constructed on a relatively flat plain, Mingo Swamp, with the pool area completely enclosed within the embankment. The appurtenant work consists of a 36 in. diameter corrugated metal inlet pipe with gate, two 36 in. diameter corrugated metal outlet pipes with gates, and two 50 ft overflow spillway sections.

Sheets 3 through 9 of Appendix A show a plan, profile, and typical sections of the embankments.

B. Location:

The dam is located in the northwestern part of Stoddard County, Missouri in the Duck Creek State Wildlife Refuge. The dam and lake are within the Sturdivant, Missouri 7.5 minute quadrangle sheet (Section 5, T27N, R9E - latitude 37°00.5, longitude 90°06.5). Sheet 2 of Appendix A shows the general vicinity.

C. Size Classification:

With an embankment height of 7.3 ft and a maximum storage capacity of approximately 1,185 acre-ft, the dam is in the intermediate size category.

D. Hazard Classification:

The St. Louis District, Corps of Engineers has determined that this dam is in the significant hazard potential classification. The estimated damage zone extends approximately one mile downstream of the dam. Located within this zone are the town of Kinder (few dwellings), a railroad, and Highway 51. The affected features located within the potential damage zone were field verified by the inspection team.

E. Ownership:

The dam is owned by the Missouri Department of Conservation. The owner's address is P. O. Box 180, Jefferson City, Missouri 65102. A district office, Duck Creek Wildlife Management Area, is located adjacent to the pond area. Mr. Dave Shaffer is the Area Manager of the office.

F. Purpose of Dam:

The dam was constructed primarily for a state-operated wildlife refuge area.

G. Design and Construction History:

The dam was designed by the Missouri Department of Conservation in 1951 and 1952. The plans included details for Pond 1, Pond 2, and Pond 3. The details provided for Pond 3 consisted of typical outlet pipes with gate valves. Information regarding the embankment section and profile was not available. Design and construction data were obtained from conversations with the Area Manager, Mr. Dave Shaffer. The dam was constructed in 1953 by the work force of the Missouri Department of Conservation. The borrow material was obtained from the levee system constructed adjacent to the lake. The levee system encompasses the embankment area except for the north boundary of the lake. The downstream embankment of Pond 1 forms the north boundary of Pond 3.

The levee system consist of an embankment and drainage ditch along the eastern boundary between Pond 2 and Pond 3 and along the western and southern boundary of Pond 3. The drainage ditch along the west boundary of Pond 3 is designed to carry flows resulting from upland drainage and flows from Pond 1. The flows from Pond 1 are regulated by an upstream swing gate.

No design data regarding the embankment were available. The slopes of the downstream and upstream are generally 1 vertical on 3 horizontal.

H. Normal Operating Procedures:

Normal rainfall, evaporation, the inlet pipe from Pond 1, the gate controlled outlet pipes, and the overflow spillways are used to control the water surface. The pond is normally filled from Pond 1 starting in October of each year. The normal pool elevation 340.5 is maintained until the end of December when the outlet structures are opened and the pond is allowed to drain.

1.3 PERTINENT DATA:

Pertinent data about the dam, appurtenant works, and reservoir are presented in the following paragraphs. Sheets 3 through 9 of Appendix A present a plan, profile, and typical section of the embankment.

A. Drainage Area:

The drainage area for this dam, as obtained from the U.S.G.S. quad sheet, is approximately 575 acres (enclosed within the embankment area).

B. Discharge at Dam Site:

(1) All discharge at the dam site is through controlled outlet pipes and overflow spillways.

(2) Estimated Total Spillways and Outlet Pipes Capacity at Maximum Pool (Top of Dam - El. 341.3): 266 cfs

(3) Estimated Capacity of Principal Spillways: 214 cfs

(4) Estimated Capacity of Outlet Pipes: 52 cfs

(5) Estimated Capacity of Emergency Spillway: Not Applicable

(6) Estimated Experience Maximum Flood at Dam Site: Unknown

(7) Diversion Tunnel Low Pool Outlet at Pool Elevation: Not Applicable

(8) Diversion Tunnel Outlet at Pool Elevation: Not Applicable

(9) Gated Spillway Capacity at Pool Elevation: Not Applicable

(10) Gated Spillway Capacity at Maximum Pool Elevation: Not Applicable

C. Elevations:

All elevations are consistent with an assumed mean sea level elevation of 347.1 for top of concrete structure for the inlet pipe at Station 0 + 00. (Elevation obtained from plans for Pond 1 and the Phase I Inspection Report for Pond 1 dated March 1980.)

(1) Top of Dam: 341.3 MSL (low point of dam and adjacent levee embankment)

(2) Principal Spillway Crests:
Overflow Spillway 1 - Station 24 + 75, Elevation 340.5
Overflow Spillway 2 - Station 92 + 12, Elevation 340.5

(3) Principal Spillway Crests (Boards Removed):
Overflow Spillway 1 - Elevation 338.9
Overflow Spillway 2 - Elevation 337.2

(4) Outlet Pipes Inverts at Inlets:
36 in. Pipe - Station 100 + 90, Elevation 338.1
36 in. Pipe - Station 108 + 85, Elevation 338.1

(5) Emergency Spillway Crest: Not Applicable

(6) Plain Elevation at Centerline of Dam: 334.0 MSL

(7) Pool on Date of Inspection: No water in pond

(8) Apparent High Water Mark: Unknown

(9) Maximum Tailwater: Not Applicable

(10) Upstream Portal Invert Diversion Tunnel: Not Applicable

(11) Downstream Portal Invert Diversion Tunnel: Not Applicable

D. Reservoir Lengths:

(1) At Top of Dam: 5,400 ft

(2) At Emergency Spillway Crest: Not Applicable

(3) At Principal Spillway Crest: 5,410 ft

E. Storage Capacities:

(1) At Top of Dam: 1,185 Acre-ft

(2) At Emergency Spillway Crest: Not Applicable

(3) At Principal Spillway Crest: 725 Acre-ft

F. Reservoir Surface Areas:

(1) At Top of Dam: 575 Acres

(2) At Emergency Spillway Crest: Not Applicable

(3) At Principal Spillway Crest: 574 Acres

G. Dam:

(1) Type: Rolled Earth

(2) Length at Crest: 14,700 ft

(3) Height: 7.3 ft

(4) Top Width: 15 ft

(5) Side Slopes: Upstream 1V on 3H
Downstream 1V on 3H

(6) Zoning: Apparently Homogeneous

(7) Impervious Core: None

(8) Cutoff: Unknown

(9) Grout Curtain: None

H. Diversion and Regulating Tunnel:

(1) Type: Not Applicable

(2) Length: Not Applicable

(3) Closure: Not Applicable

(4) Access: Not Applicable

(5) Regulating Facilities: Not Applicable

I. Spillway:

I.1 Principal Spillways:

(1) Location: Station 24 + 75 and Station 92 + 12

(2) Type: Two overflow spillway sections (50 ft wide)

(3) Upstream Channel: Earth cut channel extending into lake area

(4) Downstream Channel: Earth cut channel to adjacent drainage ditch paralleling embankment

I.2 Emergency Spillway:

(1) Location: Not Applicable

(2) Type: Not Applicable

(3) Upstream Channel: Not Applicable

(4) Downstream Channel: Not Applicable

J. Regulating Outlets:

The regulating outlets associated with this dam are the slide gates for the two 36 in. CMP's and for the one 36 in. inlet CMP.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN:

The engineering design data consist of a set of plans and drawings for the entire Duck Creek Wildlife Refuge. The plans obtained from the Missouri Conservation Department were primarily for the construction of Pond 1 and the levee system for the refuge. Reference was made to Pond 3, but no design drawings were present in the plans. No design computations or reports are available.

A. Surveys:

The most recent survey conducted in the area was for the preparation of the Phase I Safety Inspection for Pond 1, report dated March 1980. Sheets 3 through 9 of Appendix A present a plan, profile, and cross section of the dam from survey data obtained during the site inspection. A site benchmark elevation of 347.1 for the top of the concrete structure at the inlet gate pipe was used. The elevation of the structure was obtained from the Phase I inspection of Pond 1.

B. Geology and Subsurface Materials:

The Duck Creek State Wildlife Refuge - Pond 3 Dam is located near the western edge of the Southeastern Lowlands geologic region of Missouri. The area is characterized topographically by its flatness. The dam is located on the braided stream terrace deposits of the Pleistocene. The underlying sand is the alluvium of the Mississippi-Ohio River complex while the loessial sand, sandy clay, and clay are the McNary formation of the Cretaceous. The thickness of the Cretaceous System in southeastern Missouri ranges from 100 to 250 ft. Braided stream deposits consist of material eroded from the uplands to the east of the dam site. The material has been dissected by small streams in the area which generally flow in a parallel direction.

The Duck Creek State Wildlife Refuge - Pond 3 Dam is a rectangular shaped structure which was erected on a flat plain. The embankments were constructed by using on site material which consisted of sands, silts, and clays. The surface material of the site is underlain by sand which in turn is underlain by nonmarine sand and sandy clay.

The publication "Caves of Missouri" lists three caves known to exist in Stoddard County. The closest cave is approximately 5 miles east of the site. The dam is located in seismic zone 3.

C. Foundation and Embankment Design:

No foundation and embankment design information was available. Seepage and stability analyses apparently were not performed as required in the guidelines. There is apparently no particular zoning of the embankment, and no internal drainage features are known to exist.

D. Hydrology and Hydraulics:

No hydrologic and hydraulic design computations for this dam were available. The two 36 in. diameter gated CMPs were considered to be open. The two 50 ft overflow structures, with associated boards in place to normal pool elevation of 340.5, were considered to act as the principal spillway. No emergency spillway section was provided for the dam. Based on a check of the CMP outlet pipes, overflow spillways, embankment elevations, and a check of the drainage area on U.S.G.S. quad sheets, hydrologic analyses using U. S. Army Corps of Engineers guidelines were performed and appear in Appendix C, Sheets 1 to 9.

E. Structure:

The structures associated with this dam include the gated 36 in. inlet pipe structure, the two 36 in. outlet pipes, and the concrete overflow structures. The slide gates for the three outlet pipes are located in a concrete structure on the lake side of the embankment.

2.2 CONSTRUCTION:

No construction inspection data have been obtained.

2.3 OPERATION:

The normal pool elevation of 340.5 is maintained only during the fall of the year. Usually in October of each year, the inlet gate from Pond 1 is opened to fill the lake to elevation 340.5. The level is maintained until after the duck hunting season, the latter part of December, when the lake level is lowered by the two gated spillway pipes and by removal of the boards from the overflow structures.

2.4 EVALUATION:

A. Availability:

The engineering data available are as listed in Section 2.1.

B. Adequacy:

The engineering data available were inadequate to make a detailed assessment of the design, construction, and operation of this structure. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

C. Validity:

To our knowledge, no valid engineering data on the design or construction of the embankment are available. The engineering data available were principally for the construction of Pond 1 and the surrounding levee system.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS:

A. General:

The field inspection was made on October 8, 1980. The inspection team consisted of personnel from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The team members were:

Steven L. Brady - Anderson Engineering, Inc. - Civil Engineer
Tom R. Beckley - Anderson Engineering, Inc. - Civil Engineer
Gene Wertepny - Hanson Engineers, Inc. - Hydraulic Engineer
Dan Kerns - Hanson Engineers, Inc. - Geotechnical Engineer

The Area Manager, Mr. Dave Shaffer, was to accompany the inspection team. However, his services were required elsewhere within the area and no replacement personnel were available during the course of the inspection.

Photographs of the dam, appurtenant structures, reservoir, and downstream features are presented in Appendix D.

B. Dam:

Pond 3 is a unique dam and lake as the impounded water is completely enclosed within an embankment. The embankment for Pond 3 extends along the east, south, and west sides of the normal pond area. Immediately north of the lake is the 9.5 ft high embankment for Pond 1. On the date of inspection, filling of Pond 3 had not commenced. A small amount of surface water was observed in the pond area. The inlet gate from Pond 1 is normally opened the middle of October to allow flow into Pond 3.

The embankment appeared to be in good condition. The gravel covered crest of the embankment was well maintained, with a width of 15 ft.

The vertical alignment of the crest was generally good, with some irregularities of the profile observed (See Sheets 4 and 5 of Appendix A).

Embankment slopes on the upstream and downstream slopes were 1V on 3H. The upstream and downstream slopes were tree covered, varying from scattered to a dense growth.

A navigation channel, with navigation fingers extending into the pond area, was noted along the east, south, and west boundaries of the pond (see Photograph Nos. 2, 6, and 8). These channels provided boat access to the duck blinds within the pond.

No significant erosion or other unusual movement of the embankment was noted. No animal burrows were observed.

The construction material for the embankment was obtained from the excavation of the adjacent levee system. The levee is continuous around the embankment except along the north perimeter, which was the embankment for Pond 1. The levee system provides for upland drainage and for carrying discharges from Ponds 1, 2, and 3. The levee embankment, which was densely covered with tree and brush growth, varied from a maximum of 3 ft above the dam embankment along the western boundary to equal elevation with the dam embankment along the east and south boundary. Intermittent openings through the levee embankment to the drainage ditch was noted at the overflow structures and the outlet pipes. Additional random spaced openings were observed around the perimeter of the levee embankment.

Shallow auger probes into the crest of the embankment indicate the dam to be constructed of a dark gray silty clay (CL).

C. Appurtenant Structures:

C.1 Principal Spillway:

The principal spillway system for this dam includes the two 50 ft wide overflow spillway sections. (See Photograph Numbers 4 and 11). The crest of the spillway is varied by the placement of boards between the vertical posts. The tops of the boards, during the fall of the year when water is impounded, are set at elevation 340.5 (normal pool). The concrete support structure, posts, and inserted boards appeared to be in good condition. Additional structures associated with the dam, are the two 36 in. diameter gated CMPs and the uncontrolled 9 in. diameter CMP. The two 36 in. diameter gated pipes are used to drain the lake area and to provide some control of the pool level. All of the pipes and control structures appeared to be in good condition. The 9 in. CMP is used to provide water storage to a small marshy area immediately south of the southeastern corner of the dam.

C.2 Emergency Spillway:

There is no emergency spillway associated with this dam.

D. Reservoir:

The reservoir area, which is contained entirely within the embankment, is a flat, wooded surface with some agricultural terrain. The seeded areas provide a source of food for the ducks. No excessive erosion, slides, or wave wash were observed. Siltation of the reservoir appeared to be minor.

E. Downstream Channel:

The downstream channels, consisting of the refuge levee system, were well maintained and in relatively good condition. Beyond the levee, the channel is barely discernible in the broad flat valley.

3.2 EVALUATION:

The maintenance of the levee, embankment, and the discharge structures appears to be adequate except for the dense tree and brush growth. Due to the low height of the embankment, the broad floodplain below the dam, and the relatively short time duration of water storage, none of the conditions observed are significant enough to indicate a need for immediate action of a serious potential of failure. If left uncontrolled, the dense growth of trees and brush on the downstream slope could lead to the development of potential problems.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES:

The drainage area of the lake is entirely enclosed within the embankment. The pool level is usually maintained at normal pool only during the duck hunting season. No permanent water storage is maintained during the rest of the year. Normal rainfall, evaporation, and the control structures are utilized to provide the desired pool elevation. The water for filling the pond prior to the duck hunting season is diverted from Pond 1 through the 36 in. inlet pipe between Pond 1 and Pond 3. No information was available as to how long the gate from Pond 1 must be open to allow Pond 3 to reach its desired water level.

4.2 MAINTENANCE OF DAM:

The crest of the dam and the slopes, except for the dense tree growth, are well maintained. No riprap was used along the shoreline, although erosion of the slope does not appear to be a problem.

4.3 MAINTENANCE OF OPERATING FACILITIES:

All hydraulic structures are well maintained and appear to be in good operating condition.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT:

The inspection team is unaware of any existing warning system for this dam.

4.5 EVALUATION:

The operational and maintenance schedules appear to be adequate for the dam and appurtenant structures.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES:

A. Design Data:

No hydrologic or hydraulic design computations for this dam were available.

B. Experience Data:

No recorded rainfall, discharge, or reservoir stage data were available for this lake. Mr. Shaffer has indicated the dam has never been overtopped. The maximum water level within the lake was not available. Our hydrologic and hydraulic analyses using U. S. Army Corps of Engineers guidelines appear in Appendix C.

C. Visual Observations:

The only source of inflow other than the direct rainfall into the lake is through the gated inlet pipe from Pond 1. This gate is used only prior to duck hunting season to fill Pond 3. The two 36 in. outlet pipe gated structures are normally open except for the time Pond 3 is being filled and during duck hunting season. Likewise the boards in the overflow spillway 1 and 2 are removed except when the pond is filling and held at normal pool level. The lake area is maintained as a green belt by the Conservation Department.

D. Overtopping Potential:

The hydraulic and hydrologic analyses (using the U. S. Army Corps of Engineers guidelines and the HEC-1 computer program) were based on: (1) a field survey of the discharge structure dimensions and embankment elevations; and (2) reservoir storage and the pool and drainage areas from the Missouri Conservation Commission plans.

Based on the hydrologic and hydraulic analysis presented in Appendix C, overtopping of the dam will occur for discharge in excess of 35 percent of the Probable Maximum Flood (PMF). The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The recommended guidelines from the Department of the Army, Office of the Chief of Engineers, require that this structure (intermediate size with significant

downstream hazard potential) pass or store 50 percent to 100 percent of the PMF, without overtopping. Considering the dam's small size, the low storage capacity, and the short duration of permanent water impoundment, 50 percent of the PMF has been determined to be the appropriate design flood. The routing study indicates that a 1 percent probability flood will be totally stored in the reservoir without overtopping the dam.

Application of the probable maximum precipitation (PMP), resulted in a flood hydrograph peak inflow of 20,500 cfs. For 50 percent of the PMF, the peak inflow was 10,250 cfs.

The routing of the PMF, assuming that the gates will be fully opened indicates that the dam will be overtopped by 0.8 ft at elevation 342.1. The duration of the overtopping will be 11.2 hours, and the maximum outflow will be 5,650 cfs. The routing of 50 percent of the PMF indicates that the dam will be overtopped by 0.3 ft at elevation 341.6. The maximum outflow will be 620 cfs, and the duration of overtopping will be 9.3 hours. Overtopping of the embankment, due to the routing of 50 percent of the PMF, will be along the western boundary of the pond. Flows will then be diverted to the drainage ditch beyond the levee embankment through the intermittent levee embankment openings. Overtopping of the embankment by 0.3 ft is not expected to cause serious damage to the embankment.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY:

A. Visual Observations:

Observed features which could adversely affect the structural stability of this dam are discussed in Sections 3.1B and 3.2.

B. Design and Construction Data:

No design and construction data for Pond 3 were available. Seepage and stability analyses comparable to the requirements of the guidelines were not available, which constitutes a deficiency which should be rectified.

C. Operating Records:

No operating records have been obtained.

D. Post-Construction Changes:

No post-construction changes to the dam have been reported.

E. Seismic Stability:

The structure is located in seismic zone 3. Since the dam is located in seismic zone 3, it is possible that an earthquake could occur of sufficient intensity to cause severe damage or failure of the embankment.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT:

This Phase I inspection and evaluation should not be considered as being comprehensive since the scope of work contracted for is far less detailed than would be required for an in-depth evaluation of dams. Latent deficiencies, which might be detected by a totally comprehensive investigation, could exist.

A. Safety:

The embankment is generally in good condition. The dense tree and brush growth on the upstream and downstream is a deficiency which should be corrected and controlled.

Another deficiency was the lack of seepage and stability analyses records.

The dam will be overtopped by flows in excess of 35 percent of the Probable Maximum Flood.

B. Adequacy of Information:

The conclusions in this report were based on review of the information listed in Section 2.1, the performance history as related by others, and visual observation of external conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

C. Urgency:

The remedial measures recommended in paragraph 7.2 should be considered by the owner. If the deficiencies listed in paragraph A are not corrected, and if good maintenance is not provided, the embankment condition will deteriorate and possibly could become serious in the future.

Based upon the small height of the dam, the broad floodplain, and the lack of permanent water impoundment, except during October to December, the deficiencies are not as serious to the safety of the dam as would normally be expected of an intermediate size dam.

D. Necessity for Additional Inspection:

Based on the result of the Phase I inspection, no Phase II inspection is recommended.

E. Seismic Stability:

The structure is located in seismic zone 3. Since this dam is located in seismic zone 3, it is possible that an earthquake could occur of sufficient intensity to cause severe damage or failure of the embankment.

7.2 REMEDIAL MEASURES:

The following remedial measures and maintenance procedures are recommended. All remedial measures should be performed under the guidance of a professional engineer experienced in the design and construction of dams.

A. Alternatives:

(1) Spillway size and/or height of dam could be increased to pass 50 percent of the PMF. In either case, the spillway should be protected to prevent erosion.

B. O & M Procedures:

(1) Seepage and stability analyses comparable to the requirements of the recommended guidelines should be performed by an engineer experienced in the construction of dams.

(2) A detailed inspection of the dam should be made periodically by an engineer experienced in the design and construction of dams.

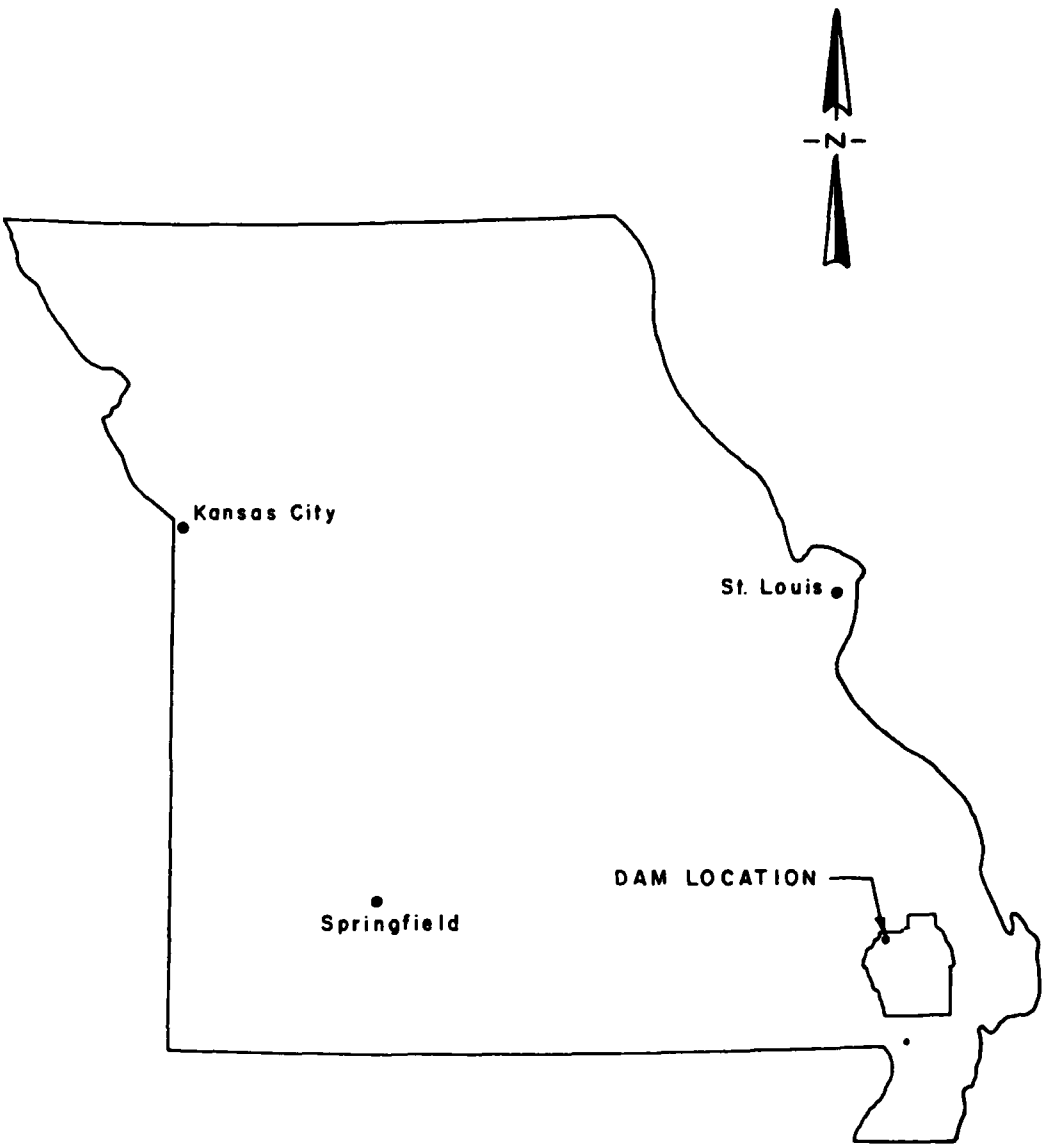
(3) Brush and tree growth should be removed from the embankment. This should be done under the guidance of a professional engineer experienced in the design and construction of dams. Indiscriminate clearing methods could jeopardize the safety of the dam.

(4) The spillway gate valves should be inspected and maintained periodically.

(5) Operational procedures should be written to include provisions for personnel to be available to open the gate valves during periods of anticipated high water.

APPENDIX A

Dam Location and Plans

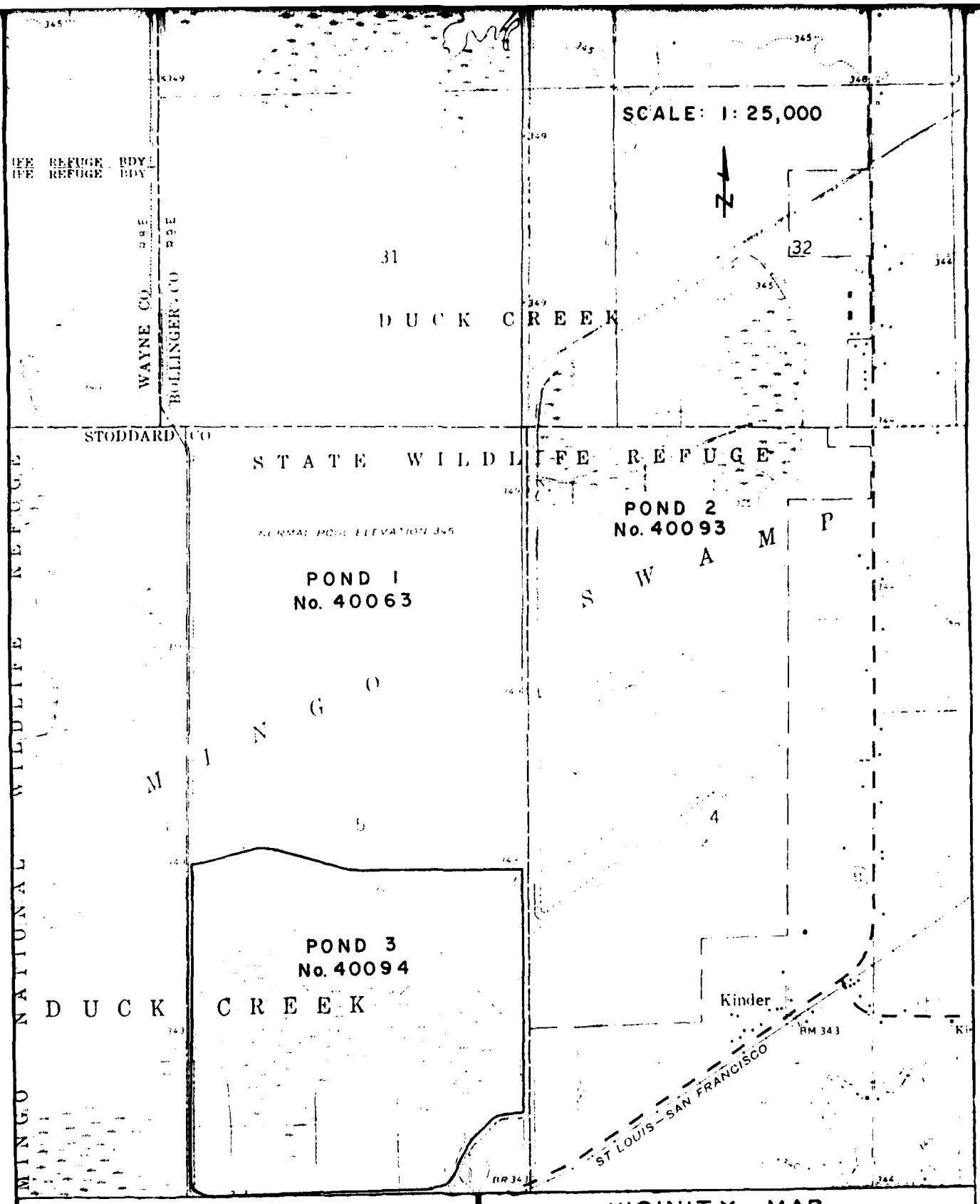


A/E ANDERSON ENGINEERING, INC.
730 N. BENTON AVE. • SPRINGFIELD, MO. 65802

LOCATION MAP

DUCK CREEK STATE WILDLIFE REFUGE #3
STODDARD COUNTY, MISSOURI
MO. I. D. No. 40094

SHEET 1, APPENDIX A

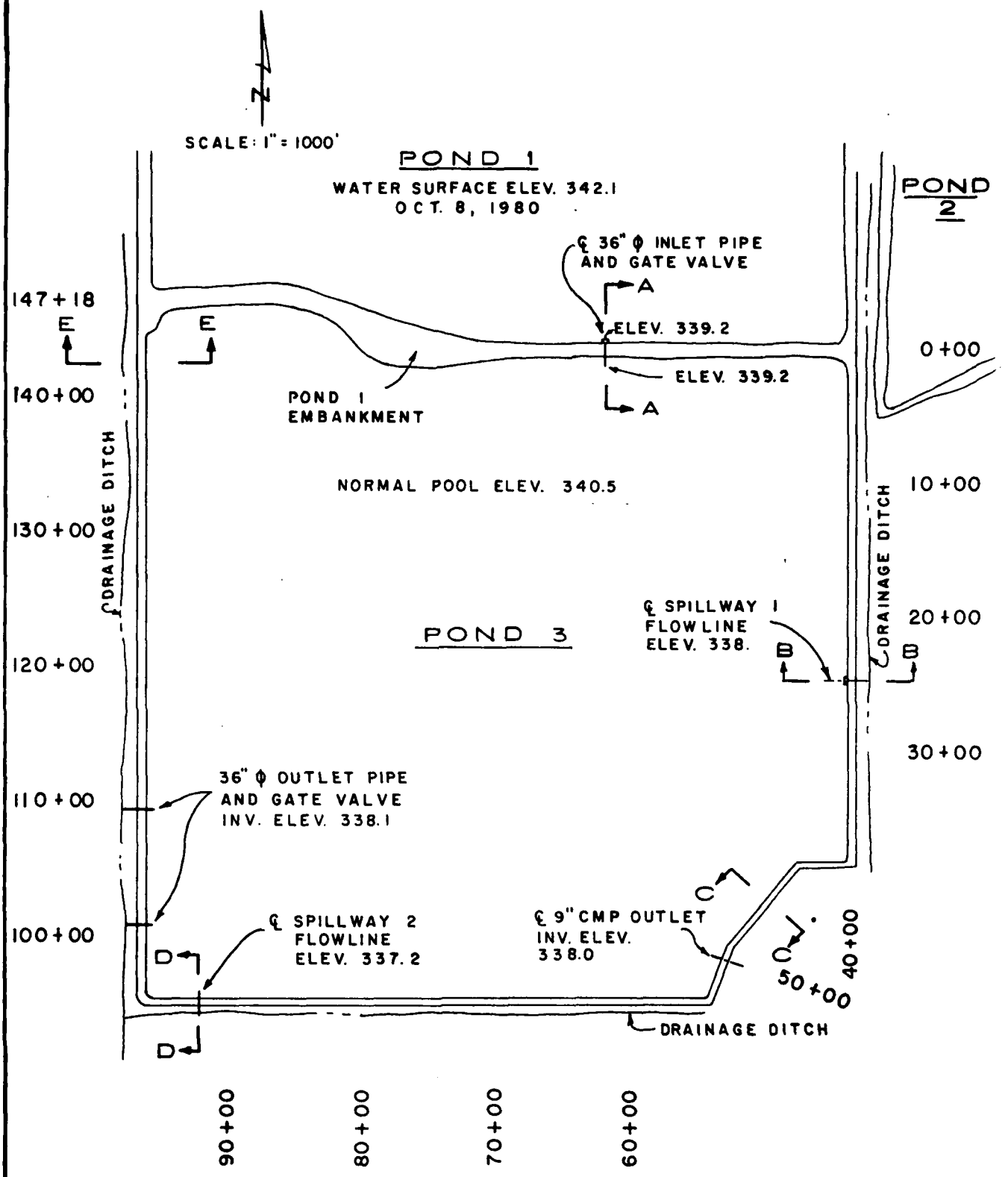


VICINITY MAP

DUCK CREEK STATE REFUGE #3
STODDARD COUNTY, MISSOURI
MO. I.D. No. 40094

A/E ANDERSON ENGINEERING, INC.
730 N. BENTON AVE. • SPRINGFIELD, MO. 65802

SHEET 2 , APPENDIX A



A/E ANDERSON ENGINEERING, INC.
730 N. BENTON AVE. • SPRINGFIELD, MO. 65802

DUCK CREEK STATE REFUGE #3
STODDARD COUNTY, MISSOURI
MO. I.D. No. 40094

PLAN VIEW

SHEET 3 , APPENDIX A

A/E ANDERSON ENGINEERING, INC.

730 N. BENTON AVE. • SPRINGFIELD, MO. 65802

DUCK CREEK STATE REFUGE #3

STODDARD COUNTY, MISSOURI

MO. I. D. No. 40094

PROFILE

SHEET 4 , APPENDIX A

A/E ANDERSON ENGINEERING, INC.
730 N. BENTON AVE. • SPRINGFIELD, MO. 65802

DUCK CREEK STATE REFUGE #3
STODDARD COUNTY, MISSOURI
MO. I.D. No. 40094

PROFILE

A/E ANDERSON ENGINEERING, INC.

720 N. BENTON AVE. • SPRINGFIELD, MO. 65802

DUCK CREEK STATE REFUGE #3

STODDARD COUNTY, MISSOURI

MO. I.D. No. 40094

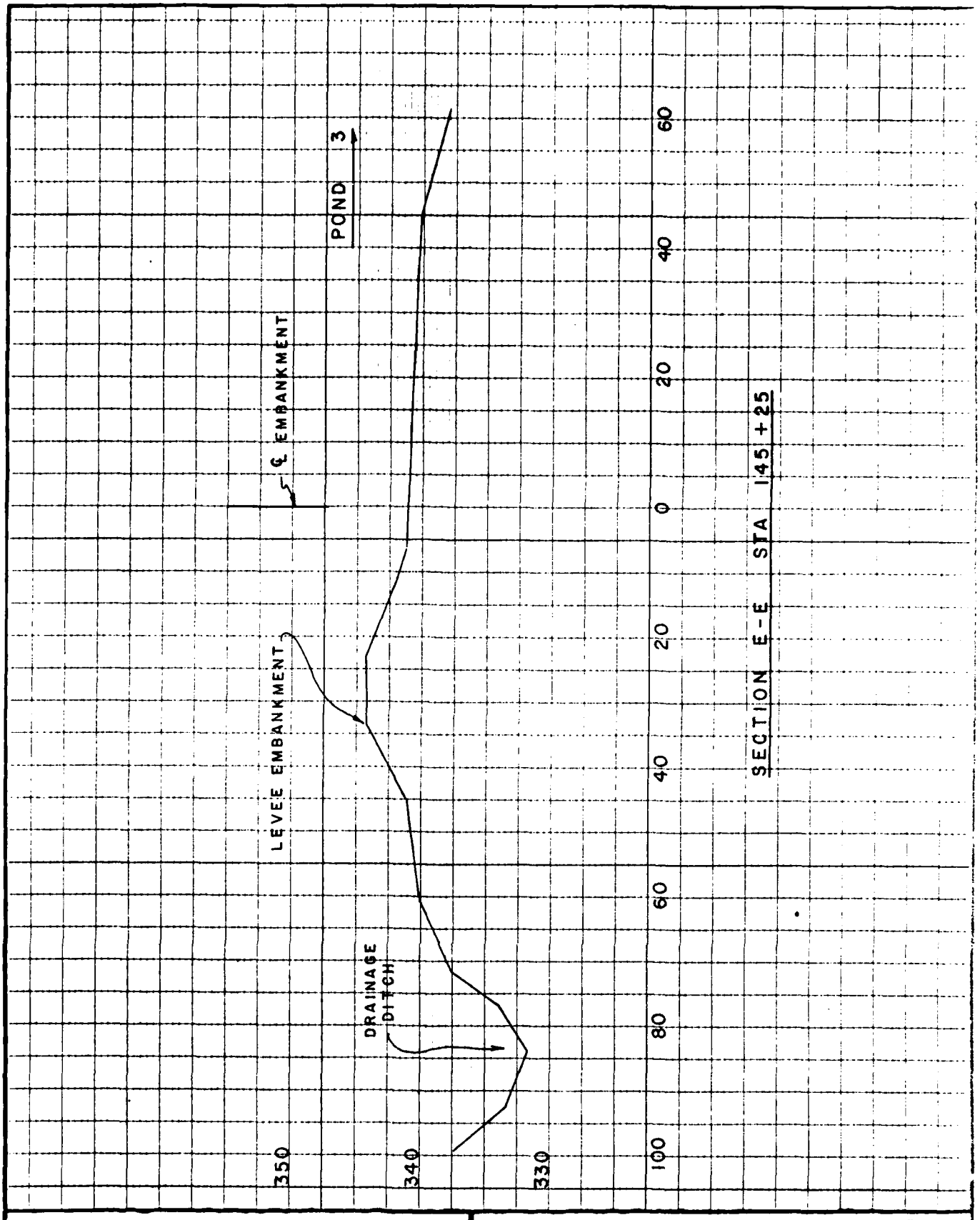
CROSS-SECTIONS

SHEET 6, APPENDIX A

A/E ANDERSON ENGINEERING, INC.
730 N. BENTON AVE. • SPRINGFIELD, MO. 65802

DUCK CREEK STATE REFUGE #3
STODDARD COUNTY, MISSOURI
MO. I.D. No. 40094

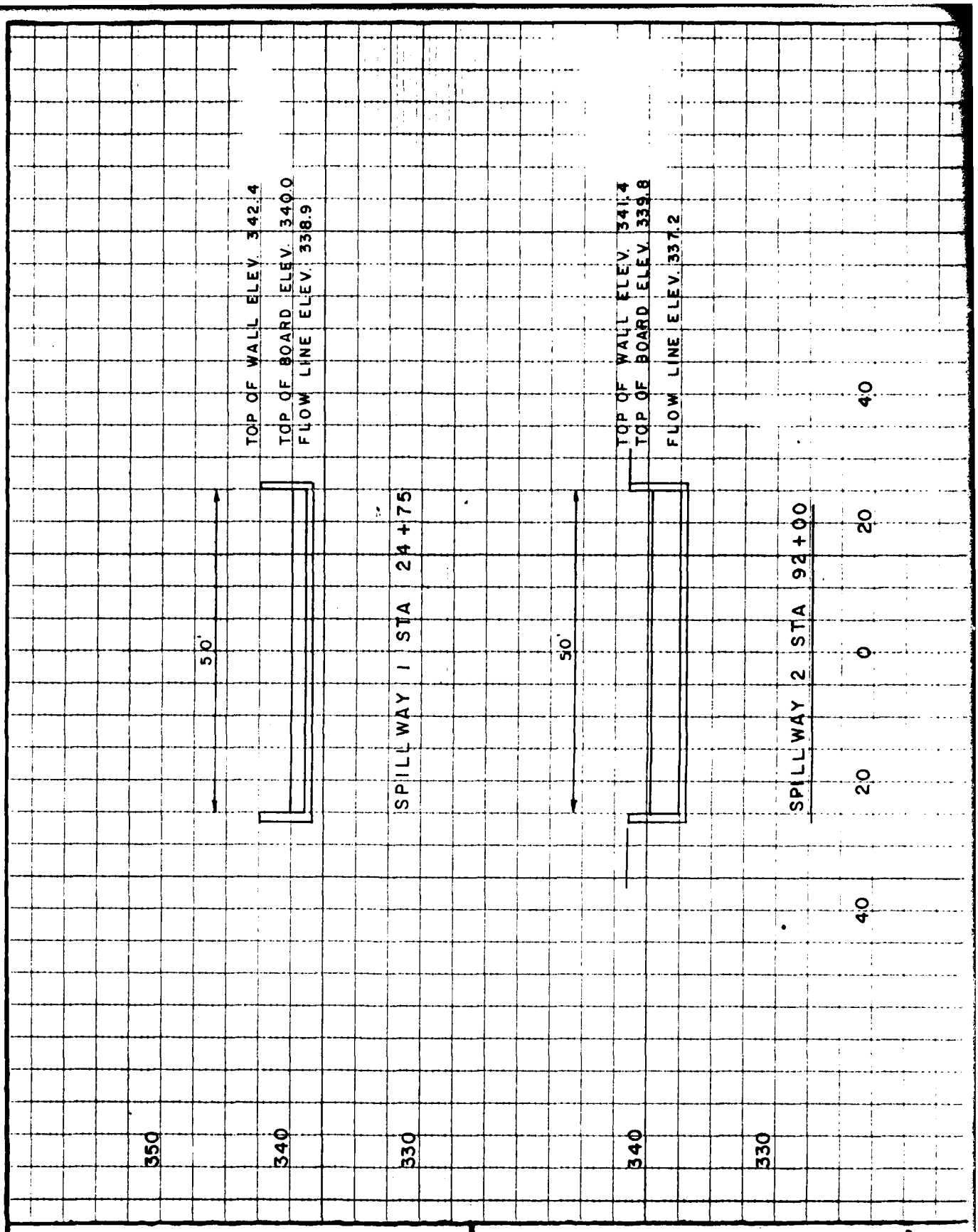
CROSS-SECTIONS



A/E ANDERSON ENGINEERING, INC.
730 N. BENTON AVE. • SPRINGFIELD, MO. 65802

DUCK CREEK STATE REFUGE #3
STODDARD COUNTY, MISSOURI
MO. I. D. No. 40094

CROSS-SECTIONS



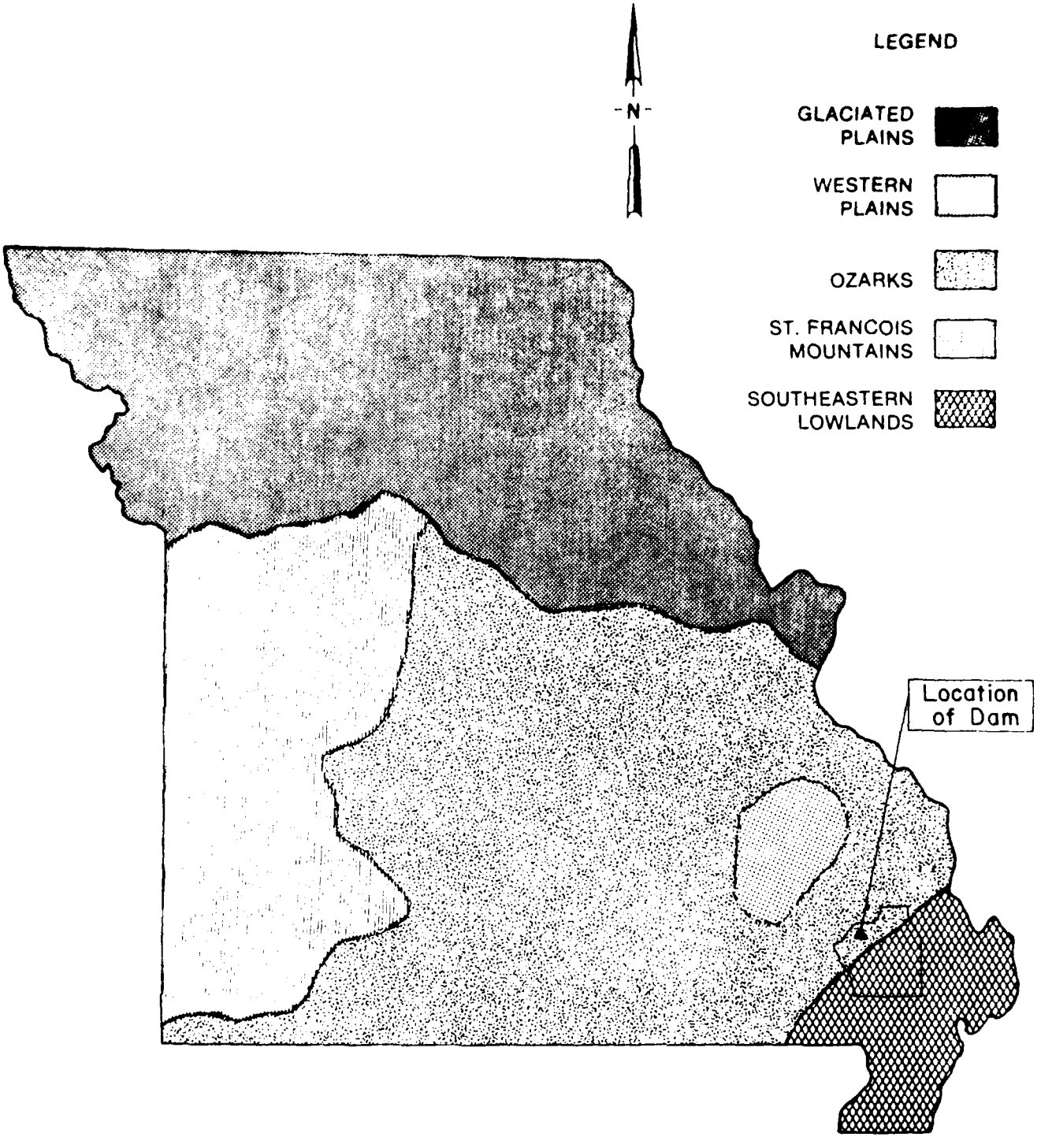
A/E ANDERSON ENGINEERING, INC.
730 N. BENTON AVE. • SPRINGFIELD, MO. 65802

DUCK CREEK STATE REFUGE #3
STODDARD COUNTY, MISSOURI
MO. I.D. No. 40094

CROSS-SECTIONS

APPENDIX B

Geology and Soils



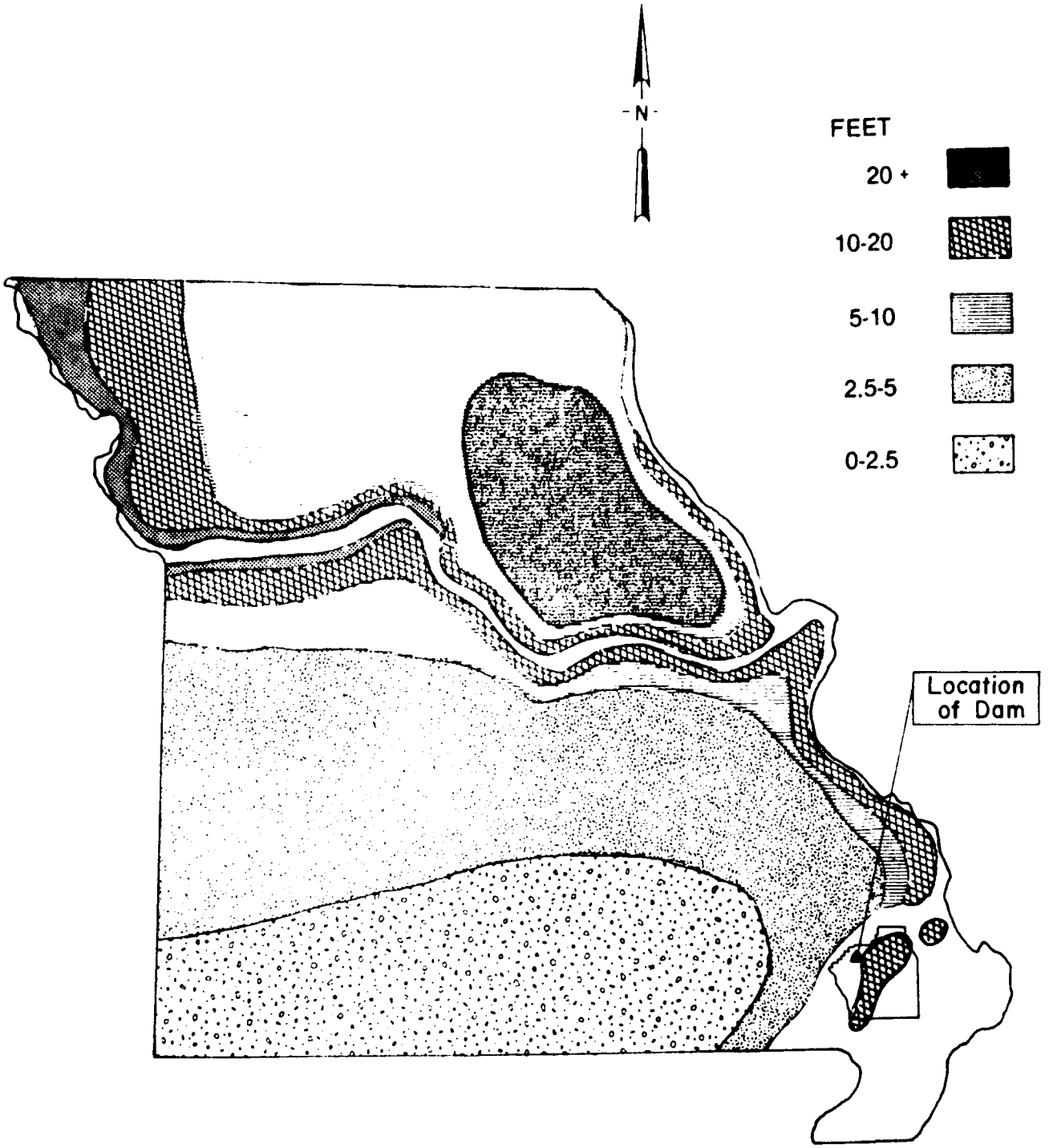
MAJOR GEOLOGIC REGIONS OF MISSOURI

HANSON ENGINEERS

SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Duck Creek State Wildlife Refuge #3 Dam
Stoddard County, Missouri
Mo. I.D. No. 40094

SHEET 1, APPENDIX B



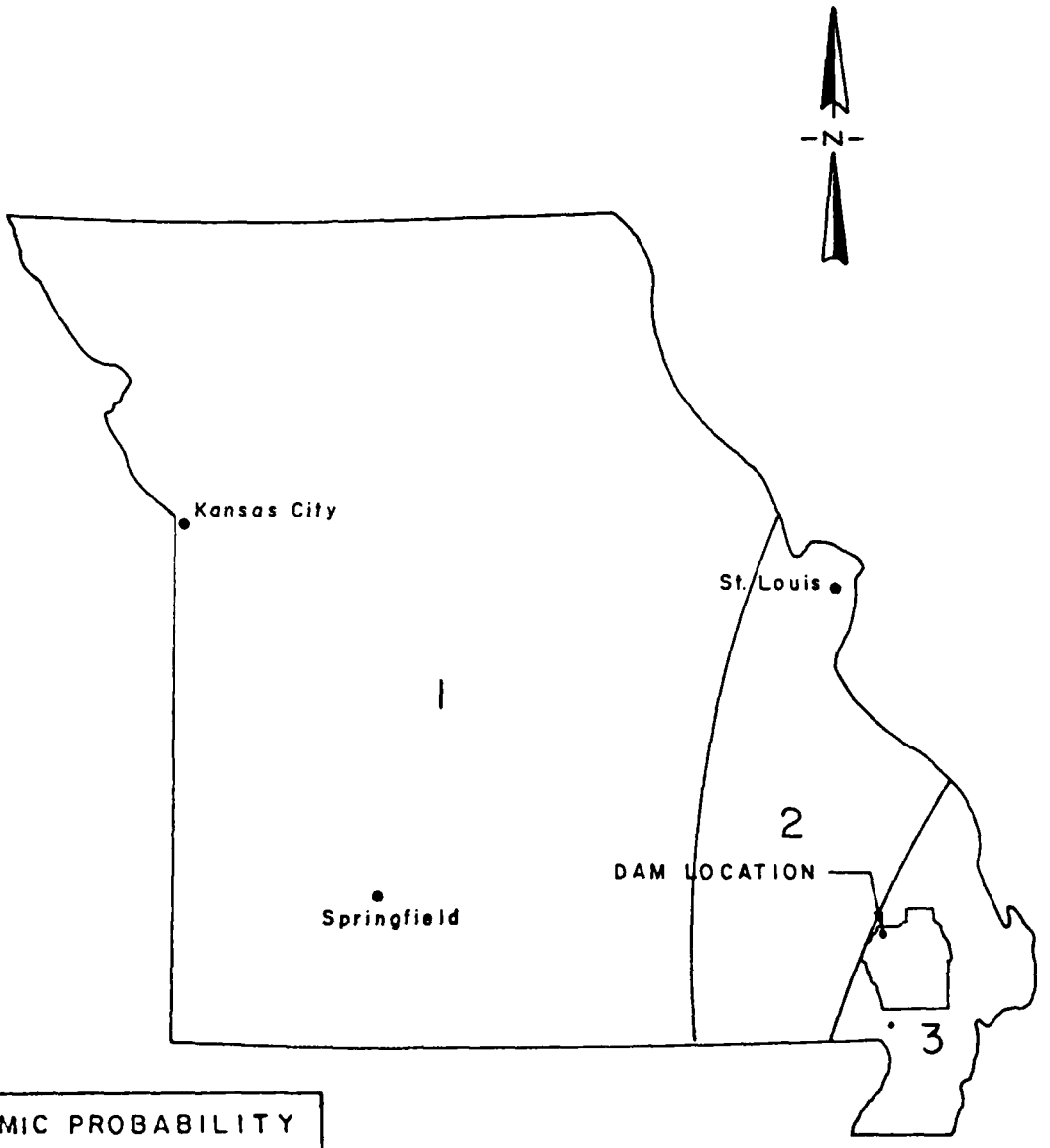
THICKNESS OF LOESSIAL DEPOSITS

HANSON ENGINEERS

SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Duck Creek State Wildlife Refuge #3 Dam
Stoddard County, Missouri
Mo. I.D. No. 40094

SHEET 2, APPENDIX B



SEISMIC PROBABILITY	
ZONE	DAMAGE
1	MINOR
2	MODERATE
3	MAJOR

A/E ANDERSON ENGINEERING, INC.
730 N. BENTON AVE. • SPRINGFIELD, MO. 65802

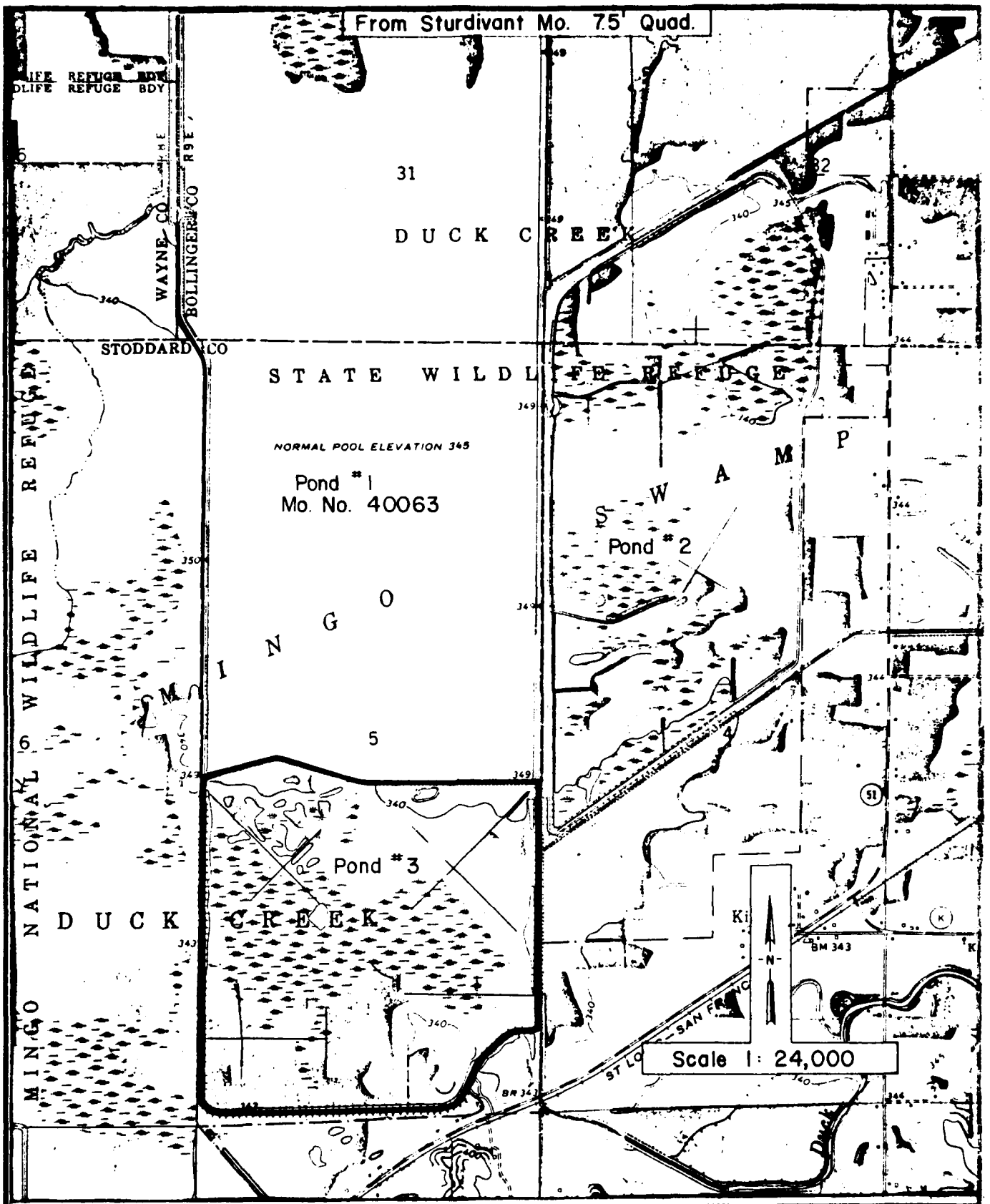
SEISMIC ZONE MAP

DUCK CREEK STATE WILDLIFE REFUGE #3
STODDARD COUNTY, MISSOURI
MO. I. D. No. 40094

SHEET 3, APPENDIX B

APPENDIX C

Overtopping Analysis



LAKE AND WATERSHED MAP

HANSON ENGINEERS INCORPORATED

SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Duck Creek State Wildlife Refuge #3 Dam
Stoddard County, Missouri
Mo. I.D. No. 40094

Sheet 1, Appendix C

APPENDIX C

HYDROLOGIC AND HYDRAULIC ANALYSIS

To determine the overtopping potential, flood routings were performed by applying the Probable Maximum Precipitation (PMP) to a synthetic unit hydrograph to develop the inflow hydrograph. The inflow hydrograph was then routed through the reservoir and spillway. The overtopping analysis was accomplished using the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California.

The PMP was determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33." Reduction factors were not applied. The rainfall distribution for the 24-hour PMP storm duration was assumed according to the procedures outlined in EM 1110-2-1411 (SPD Determination). This results in a PMP value of 27.2 in. for 200 sq miles and 102, 120, 130 percent of PMP for 6, 12, 24 hrs duration respectively. The total 24-hour PMP for the Duck Creek State Wildlife Refuge-Pond 3 drainage area results in 35.4 in. The drainage area is enclosed within a levee system. All rainfall was assumed to go into storage within the banks of the levee with no losses. Consequently, the storage within the reservoir will increase equal to the depth of the rainfall until overtopping occurs.

The synthetic unit hydrograph for the watershed was developed for a 5 minute rainfall (i) duration for a drainage area (A) of 574 acres. Considering that all the rainfall goes into storage:

$Q = i.A$

$i = 1$ in./5 min. = 12 in./hr = 1.0 ft/hr = 1.0 ft/3600 sec.

$A = 574$ acres $= 574\ (43,560)\ ft^2$

$Q = i.A = (1.0\ ft/3600\ sec)(574)(43,560)\ ft^2 = 6,945$ cfs

$Q = 6,945$ cfs = total discharge produced for 1 in. of rainfall over the area.

For (i) inches of rainfall:

$Q = i,$ in. $\times\ 6,945$ cfs

Consequently, the temporal distribution of inflow to the reservoir was developed by simply multiplying the rainfall in inches by 6,945 to obtain the inflow in cfs.

The reservoir routing was accomplished by using the Modified Puls Method assuming the starting lake elevation at maintained normal pool (340.5). No antecedent storm was routed in order to determine the starting elevation. Outflow from the reservoir is possible through two 50 ft overflow spillways, and two 36 in. corrugated metal pipes (CMP) controlled by gates. The invert elevations for these two pipes are below the maintained normal pool elevation. The reservoir routing was analyzed assuming that these gates will be fully open at the beginning of the routing. The results (see Sheet 8, Appendix C) indicated that overtopping will occur for discharges in excess of 35 percent of the PMF. The hydraulic capacity of the spillways and the storage capacity of the reservoir were defined by the elevation-surface area-storage-discharge relationships shown in Table 1 (Sheet 4, Appendix C).

The reservoir routing was also studied, for comparison, assuming that the two gates will remain closed during the routing. The results (see Sheet 11 of Appendix C) indicated that, in this case, the overtopping will occur for discharges in excess of 30 percent of the PMF.

The rating curve for the two overflow spillways was determined assuming critical flow over a sharp-crested weir. The rating curve for the pipes was determined assuming entrance and outlet control and using charts for corrugated metal pipes from the U.S. Bureau of Public Roads (see Table 2, Sheet 5, Appendix C).

The flow over the crest of the dam during overtopping was determined using the non-level dam option ($L and $V cards) of the HEC-1 program. The program assumes critical flow over a broad-crested weir. The lowest elevation of the crest of the dam, obtained from survey measurements, was assumed as top of dam elevation.

A summary of the routing analysis for different ratios of the PMF, assuming the gates are fully open, is shown in Table 3 (Sheet 6, Appendix C). The routing study indicates that the 1 percent probability flood (7.5 in.) will be totally stored in the reservoir without causing overtopping of the dam.

The computer input data, a summary of the output data, and a plot of the inflow-outflow hydrograph for the PMF, are presented on Sheets 7 to 11 of Appendix C.

TABLE 1

ELEVATION, SURFACE AREA, STORAGE AND DISCHARGE RELATIONSHIPS

Elevation (ft, MSL)	Lake Surface Area (acres)	Lake Storage (acre-ft)	Spillway Discharge (cfs)
338.0	0	0	0
338.5	8	2	4
339.0	179	49	12
339.5	439	204	20
340.0	536	448	34
*340.5	574	725	36
**341.3	575	1,185	266
342.0	576	1,588	624
343.0	577	2,165	1,398

*Maintained normal pool elevation
**Top of dam elevation (lowest point)

The above relationships were developed using data from the Missouri Conservation Commission Plans and the field measurements.

TABLE 2

SPILLWAYS RATING CURVE

Reservoir Elevation (MSL)	Principal Spillway (1-2) (cfs)	Outlet Pipes (2-36" CMP)	Total Discharge (cfs)
338.0	-	0	0
339.5	-	20	20
340.0	-	34	34
*340.5	0	36	36
341.0	106	42	148
**341.3	214	52	266
342.0	552	72	624
342.5	934	84	1,018
343.0	1,304	94	1,398
343.5	1,714	104	1,818
344.0	2,160	112	2,272

*Maintained normal pool elevation
**Top of dam elevation

METHOD USED:

1) Overflow Spillways: Assuming critical flow over a sharp-crested weir

Formula used: $Q = C.L.H.^{1.5}$

Q = Discharge in cubic feet per second
C = 3.3 Assumed discharge coefficient
L = 45 ft (Effective length of spillway)
H = Effective energy head.

2) Outlet Pipes: Assuming entrance and outlet control, and using charts for corrugated metal pipes from the U.S. Bureau of Public Roads.

TABLE 3

RESULTS OF FLOOD ROUTINGS
(Assuming gates fully open)

Ratio of PMF	Peak Inflow (cfs)	Peak Lake Elevation (ft, MSL)	Total Storage (acre-ft)	Peak Outflow (cfs)	Depth (ft) Over Top of Dam
-	0	*340.5	725	36	-
0.10	2,050	340.7	824	75	0
0.20	4,100	340.9	972	132	0
0.30	6,150	341.2	1,116	219	0
0.35	7,175	**341.3	1,185	266	0
0.40	8,201	341.4	1,243	394	0.1
0.45	9,226	341.5	1,293	526	0.2
0.50	10,250	341.6	1,343	620	0.3
0.75	15,376	341.9	1,519	1,661	0.6
1.00	20,500	342.1	1,664	5,650	0.8

The percentage of the PMF that will reach the top of the dam is 35 percent.

*Maintained normal pool elevation
**Top of dam elevation

```
A       OVERTOPPING ANALYSIS FOR DUCK CREEK STATE REFUGE - POND 3 DAM ( # 30 )
A       STATE ID NO. 40094  COUNTY NAME : STODDARD
A       HANSON ENGINEERS INC. DAM SAFETY INSPECTION JOB # 80S3001
B     300                5
B1      5
J       1        9        1
J1    .10      .20      .30      .35      .40      .45      .50      .75      1.0
K       0        1                                  3        1
K1       INFLOW HYDROGRAPH COMPUTATION **
M       1       -1     0.90              0.90        1                          1
P       0     27.2      102      120      130
T
U       1
U1   6945
X       0       -.1       2
K       1        2                          0        4        1
K1       RESERVOIR ROUTING BY MODIFIED PULS AT DAM SITE **
Y                                           1        1
Y1      1                                                    725       -1
Y4  338.0    339.5    340.0    340.5    341.0    341.3    341.5    342.0    342.5    343.0
Y4  343.5    344.0
Y5      0       20       34       36      148      266      504      624     1018     1398
Y5   1818     2272
$S      0        2       49      204      448      725     1185     1588     2165
$E  338.0    338.5    339.0    339.5    340.0    340.5    341.3    342.0    343.0
$$  338.0
$D  341.3
$L     15      400      650     1050     3100     6750     7050     9100    10300
$V  341.3    341.5    341.6    341.7    341.8    341.9    342.0    342.1    342.5
K      99
```

PMF RATIOS
INPUT DATA
(Assuming gates fully open)

********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8	RATIO 9
				0.10	0.20	0.30	0.35	0.40	0.45	0.50	0.75	1.00
HYDROGRAPH AT	1	0.90	1	2050.	4100.	6150.	7175.	8201.	9226.	10251.	15376.	20501.
	(	2.33)	(	58.05)(	116.11)(	174.16)(	203.19)(	232.21)(	261.24)(	290.27)(	435.40)(	580.53)
ROUTED TO	2	0.90	1	75.	132.	219.	266.	394.	526.	619.	1661.	5653.
	(	2.33)	(	2.11)(	3.75)(	6.20)(	7.53)(	11.16)(	14.90)(	17.53)(	47.03)(	160.08)

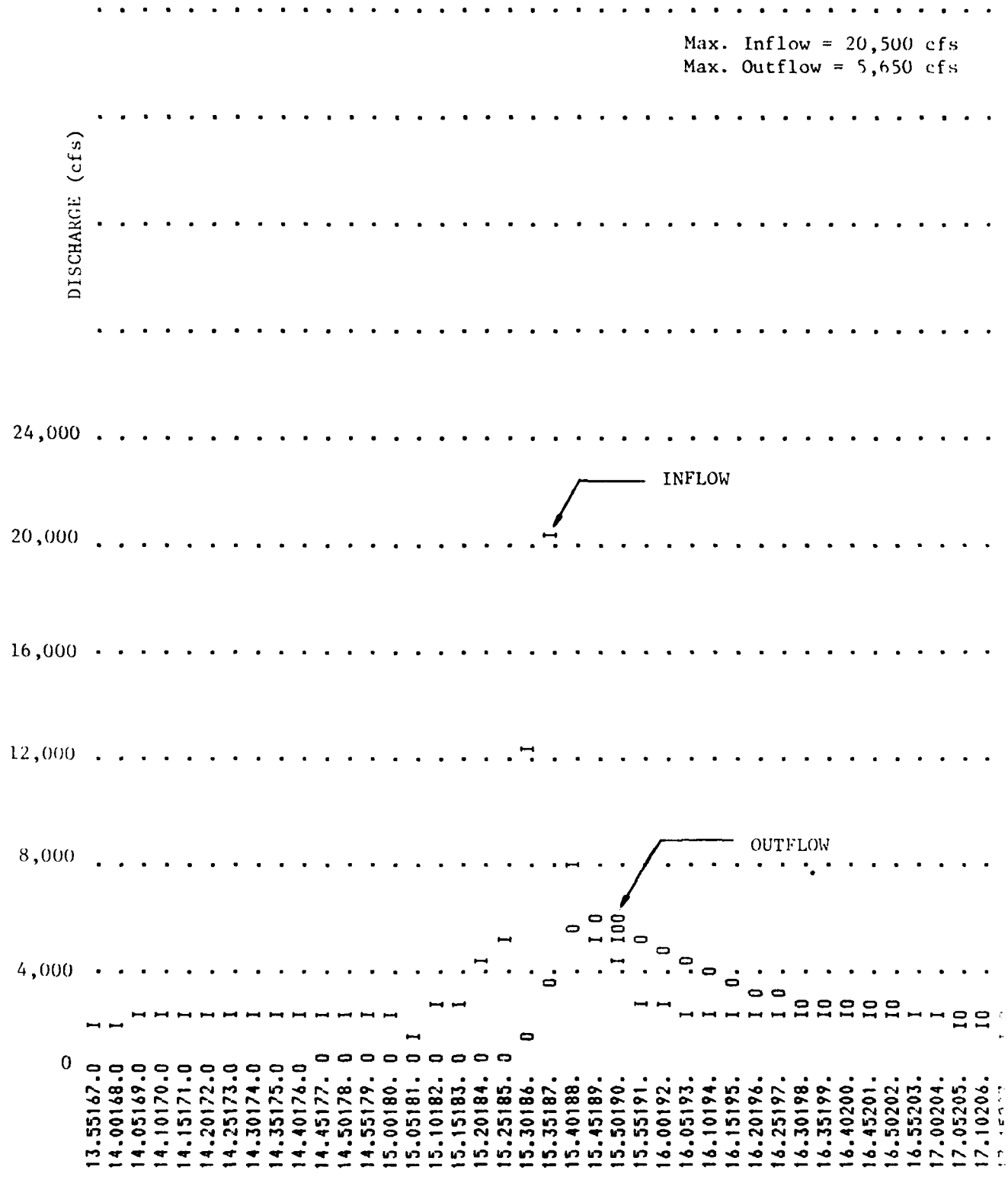
SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	340.50	338.00	341.30
# STORAGE	725.	0.	1185.
OUTFLOW	36.	0.	266.

PMF RATIOS
OUTPUT DATA
(Assuming gates fully o

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.10	340.67	0.00	824.	75.	0.00	18.92	0.00
0.20	340.93	0.00	972.	132.	0.00	19.17	0.00
0.30	341.18	0.00	1116.	219.	0.00	19.00	0.00
0.35	341.30	0.00	1185.	266.	0.00	19.00	0.00
0.40	341.40	0.10	1243.	394.	5.58	18.67	0.00
0.45	341.49	0.19	1293.	526.	7.92	18.50	0.00
0.50	341.57	0.27	1343.	619.	9.25	18.42	0.00
0.75	341.88	0.58	1519.	1661.	10.17	17.00	0.00
1.00	342.13	0.83	1664.	5653.	11.17	15.75	0.00



INFLOW-OUTFLOW HYDROGRAPH
FOR THE PMF
(Assuming gates fully open)

Sheet 9, Appendix C

```
A       OVERTOPPING ANALYSIS FOR DUCK CREEK STATE REFUGE - POND 3 DAM ( # 30 )
A       STATE ID NO. 40094  COUNTY NAME : STODDARD
A       HANSON ENGINEERS INC. DAM SAFETY INSPECTION JOB # 80S3001
B    300                5
B1     5
J      1        9        1
J1   .10      .20      .25      .30      .35      .40      .50      .75      1.0
K      0        1                                  3        1
K1      INFLOW HYDROGRAPH COMPUTATION **
M      1       -1     0.90             0.90        1                          1
P      0     27.2      102      120      130
T
U      1
U1  6945
X      0     -.1        2
K      1        2                                  0        4        1
K1      RESERVOIR ROUTING BY MODIFIED PULS AT DAM SITE **
Y                                        1        1
Y1     1                                                    725       -1
Y4 338.0    340.5    341.0    341.3    342.0    342.5    343.0    343.5    344.0
Y5     0        0      106      214      552      934     1304     1714     2160
$S     0        2       49      204      448      725     1185     1588     2165
$E 338.0    338.5    339.0    339.5    340.0    340.5    341.3    342.0    343.0
$$ 338.0
$D 341.3
$L    15      400      650     1050     3100     6750     7050     9100    10300
$V 341.3    341.5    341.6    341.7    341.8    341.9    342.0    342.1    342.5
K     99
```

PMF RATIOS
INPUT DATA
(Assuming Gates Closed)

********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

				RATIOS APPLIED TO FLOWS								
OPERATION	STATION	AREA	PLAN	RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8	RATIO 9
				0.10	0.20	0.25	0.30	0.35	0.40	0.50	0.75	1.00
HYDROGRAPH AT	1	0.90	1	2050.	4100.	5125.	6150.	7175.	8201.	10251.	15376.	20501.
	(	2.33)	(	58.05)(	116.11)(	145.13)(	174.16)(	203.19)(	232.21)(	290.27)(	435.40)(	580.53)
ROUTED TO	2	0.90	1	55.	110.	154.	198.	254.	338.	598.	1983.	6439.
	(	2.33)	(	1.51)(	3.11)(	4.37)(	5.60)(	7.18)(	9.56)(	16.92)(	56.15)(	182.33)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

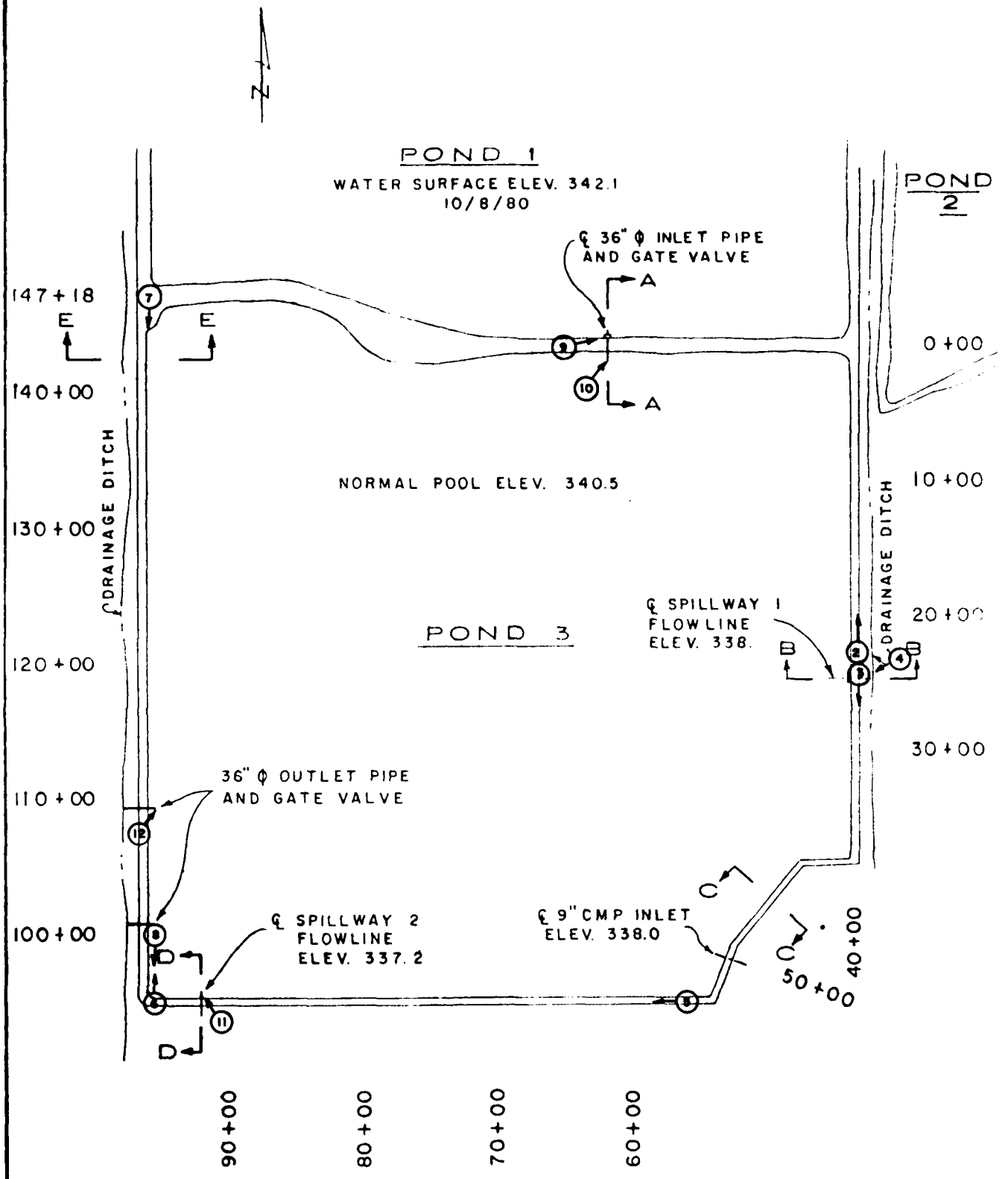
	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	340.50	338.00	341.30
STORAGE	725.	0.	1185.
OUTFLOW	0.	0.	214.

PMF RATIOS
OUTPUT DATA
(Assuming Gates Closed)

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.10	340.75	0.00	870.	53.	0.00	19.33	0.00
0.20	341.01	0.00	1019.	110.	0.00	19.33	0.00
0.25	341.13	0.00	1090.	154.	0.00	19.25	0.00
0.30	341.26	0.00	1159.	198.	0.00	19.17	0.00
0.35	341.37	0.07	1227.	254.	5.50	19.08	0.00
0.40	341.48	0.18	1290.	338.	9.08	18.83	0.00
0.50	341.66	0.36	1395.	598.	9.50	18.50	0.00
0.75	341.92	0.62	1542.	1983.	10.50	16.00	0.00
1.00	342.17	0.87	1685.	6439.	11.42	15.75	0.00

APPENDIX D

Photographs



A/E ANDERSON ENGINEERING, INC.
730 N. BENTON AVE. • SPRINGFIELD, MO. 65802

DUCK CREEK STATE REFUGE #3
STODDARD COUNTY, MISSOURI
MO. I.D. No. 40094

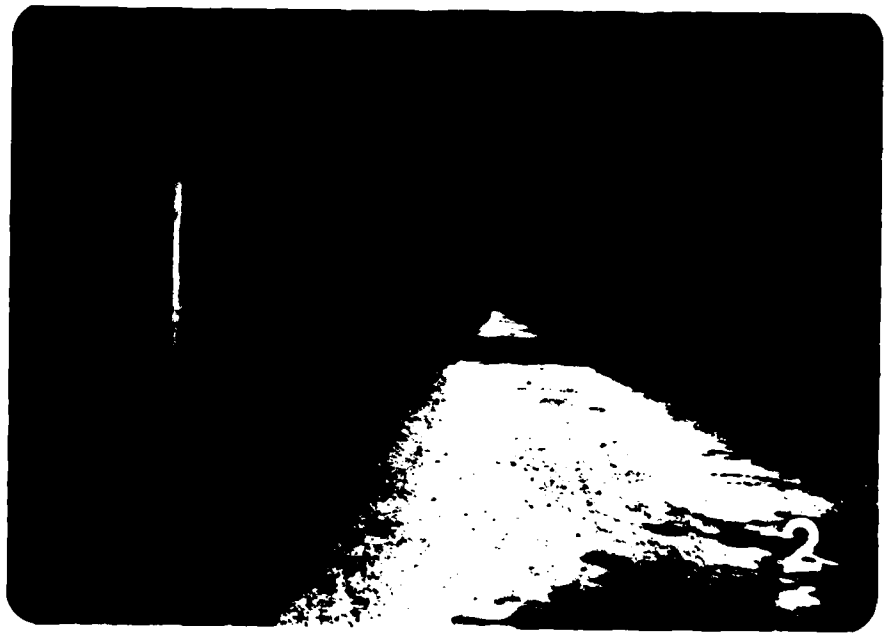
PHOTOGRAPH INDEX

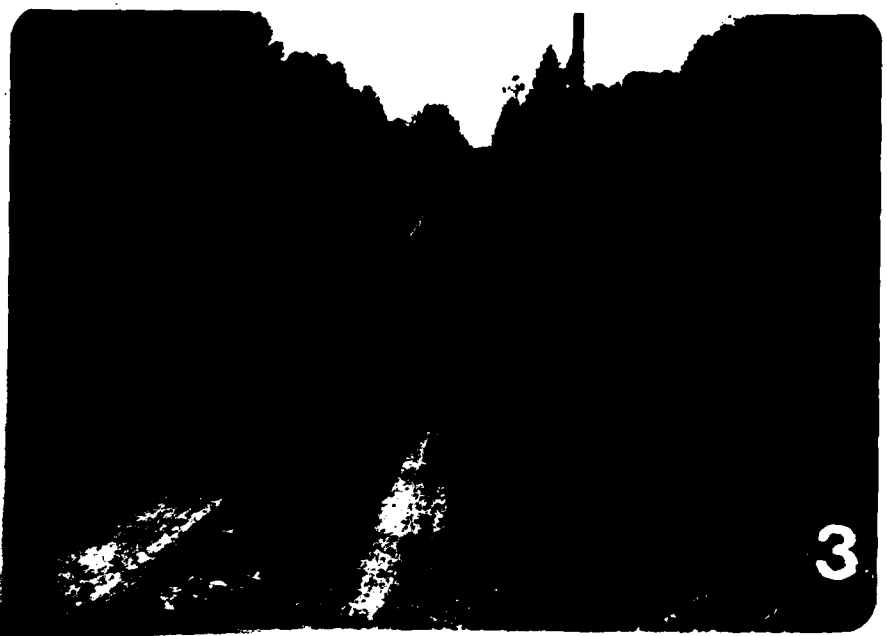
SHEET 1, APPENDIX D

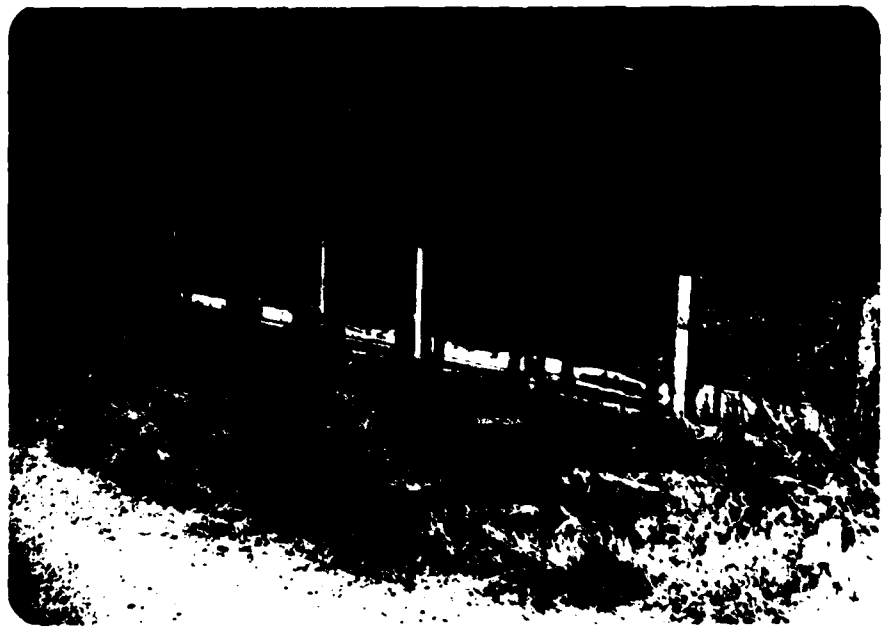
LIST OF PHOTOGRAPHS

Photo No.	Description
1	Aerial View of Lake Area (Looking West) (South boundary of dam is noted in center of photo)
2	Crest of Embankment (Looking North) Note gravel road and navigation channel
3	Swale in Crest at Spillway 1 (Looking South) Overflow structures at right side of photo. Note dense tree growth.
4	Overflow Spillway 1 (Looking West)
5	Crest of Embankment (Looking West) Note gravel road and dense tree growth
6	Crest of Embankment (Looking North) Note navigation channel at right
7	Crest of Embankment from Pond 1 Crest (Looking South) Note dense tree growth
8	Navigation Channel at Embankment (Looking South)
9	Inlet Control Structure from Pond 1 (Looking Northeast)
10	Outlet Pipe from Pond 1 (Looking North)
11	Overflow Spillway 2 (Looking North)' Note dense growth
12	Outlet Control Structure (Looking Northeast)


1


2


3




5

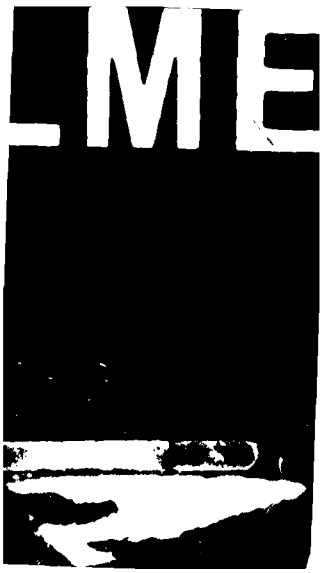

6


8


9


10


12


LME